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Charles Willis Upp

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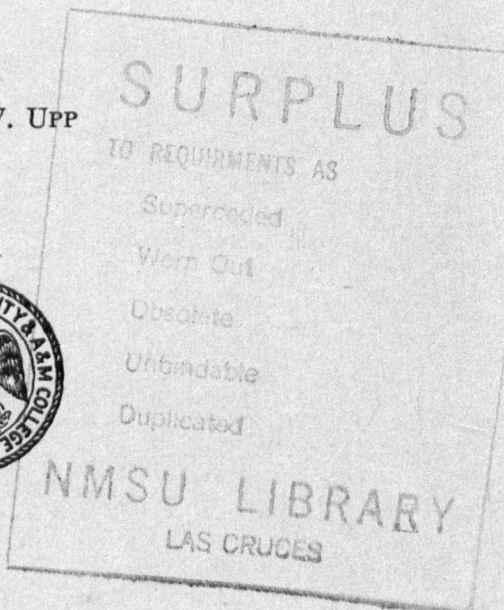
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RICE AND RICE BY-PRODUCTS AS FEEDS FOR LAYING HENS

By
CHARLES W. UPP



LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION

C. T. DOWELL
Director

ABSTRACT

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Five feeding trials involving thirty-two different lots of S. C. W. Leghorn pullets were used in this series of experiments, which extended from the fall of 1927 through the summer of 1932. The rice products tested include untreated rice bran, (heat) treated rice bran, rice polish, brewer's rice and rough rice. These products were used separately and in various combinations to replace one or more of the following feeds: wheat bran, wheat shorts, ground oats and corn meal in laying mash. Rough rice and brewer's rice were also used in the "scratch" grain to replace whole oats, whole wheat or cracked yellow corn. In the different rations used, the percentage of the total feed composed of rice products varied from 0.0% in four lots to 74.4% in one lot. In a majority of the lots, however, from 10 to 35 per cent of the total ration was composed of rice by-products. The "rice" rations used yielded satisfactory results as gauged by winter egg record, yearly egg record, hatching record, size of eggs, quality of eggs, average yearly body weight, viability of the birds and efficiency of the rations.

It is concluded that rice by-products might well be used more extensively in laying rations in this state to replace other grain by-products that are now shipped in from elsewhere.

Suggested formulas for laying rations, in which rice products are included, are given in the appendix.

ABSTRACT

ACKNOWLEDGMENTS

This series of experiments was under the active management of various workers at different times.

The first experiment was planned and conducted by Messrs. G. W. Knox, Jr., and Clyde Ingram. The project was revised in 1928 by the author and the work for that year started by him. Mr. W. M. Ginn was actively in charge of the experiments during the latter part of 1929, and until he severed his connection with this institution in 1930. Mr. Harry Smith carried on the work for the first six months of 1931. The author supervised the work from June of that year until the experiments were concluded. The data were compiled in the present form by the author.

The author wishes to acknowledge the assistance of the above named workers.

TABLE OF CONTENTS

	Pages
Abstract	1
Acknowledgments	2
Contents	3
Introduction	4- 5
Previous Investigations	6-10
Composition and Analyses of Rice By-Products.....	6- 8
Rice By-Products in Rations for Laying Hens.....	8-10
Materials and Methods	10-12
Data and Discussion	12-27
Winter Egg Production	12-13
Average Egg Production for the Experimental Year.....	13-14
Length of Productive Period.....	14
Hatching Record	14-15
Egg Size	15
Body Weight	15-16
Rough Rice as a Grain Feed for Laying Hens.....	16-17
Comparison of Hens that Died During Year to Those that Lived Throughout the Year.....	17-18
Feed Consumption and Comparative Efficiency of the Rations	19-20
Comparison of Rations—Grouped by Amount and Kind of Rice Products Contained	19-23
Total Rice Products in the Laying Ration.....	21
Rice Bran in the Laying Ration (Untreated and Treated)	21-23
Brewer's Rice in the Laying Ration.....	23
Rice Polish in the Laying Ration.....	23
Keeping Quality of Eggs from Hens Fed Rice By-Products..	24-25
Growth of Chicks from Hens Fed Various "Rice" Rations..	26-27
Summary	27-28
Conclusions	28
Literature Cited	28-30
Appendix	31-32

INTRODUCTION

Louisiana is the chief rice producing state. Rice is the principal grain crop in southwestern Louisiana, in fact in certain parishes more than three-fourths of the cultivated land is used in a rotation in which rice is included.

The average annual production of rice in the United States for the five year period of 1924 to 1928 was 38,800,000 bushels. The 1931 production was 45,200,000 bushels. Louisiana produced an average of 16,900,000 bushels for the 1924-28 period or 43.6% of the total United States crop. Thirty-eight per cent of the 1931 crop was grown in this state.

Approximately 29,000 tons (or 580,000 one-hundred pound bags) of rice bran, 11,000 tons (or 217,000 one-hundred pound bags) of rice polish, and 7,000 tons (or 140,000 one-hundred pound bags) of brewer's rice are available in the state annually for poultry and livestock feeding. Since Louisiana is a feed importing state, it is logical that these rice products should be utilized locally.

Rice by-products have been fed to livestock in Louisiana for many years as is evidenced by reports which record early experimental work and recommended rations.

No record has been found of experimental work at this institution in which rice by-products were tested in poultry rations prior to the present series of experiments. A visit through the rice producing area and correspondence with farmers in that section in 1929 indicated that rice products were not used in poultry rations as extensively nor as wisely as might have been expected. In view of the above information it seemed appropriate that experimental work be undertaken to determine the extent to which rice by-products could be utilized in poultry rations. Work was started to test rice products in rations for growing chicks and for laying hens. Only the experiments concerning laying rations are considered in this bulletin. The tests with growing rations will be reported in a bulletin to be published in the near future.

Two important factors which limit the use of rice products in poultry rations are; (1) seasonal fluctuations in the available supply of the products and (2) the lack of uniform quality of the products.

As indicated by correspondence with a number of Louisiana rice millers and with the secretary of the Rice Millers Association the rice milling season ordinarily extends over a nine to ten month period, about September 1 to July 1, however, some mills operate throughout the year. In the rice section, the products are available practically the year around, but the supply fluctuates considerably. Many poultrymen are reluctant to change rations often and desire a constant supply of the ingredients used.

The second limiting factor is of greater importance. Dependable, standardized products are desired by poultrymen. Steps have been taken by the Association of Feed Control Officials, by rice millers and by the various state feed control and inspection departments to standardize the rice by-products used as feed-stuffs, but much remains to be done. The products offered for sale vary considerably in appearance, composition and quality. Wise (1927) offers an explanation for part of this variation. He states, "Practically no two lots of rough rice as produced in the field are identically the same, nor do they receive identically the same milling, hence it is unavoidable that there is some slight variation in the composition and in the general appearance of different lots of bran."

Rice bran becomes rancid and unpalatable if held in storage for a long period. Many millers now have bran driers, but they do not heat the rice bran to temperatures as high as recommended by Browne (1904). Recent work by Coe (1932) may lead to practical measures in the control of rancidity in rice products. The solution of this problem would be of considerable value to millers and to livestock feeders.

Definitions of rice products adopted by the Association of American Feed Control Officials are as follows: (Taken from Wilson [1931]).

"Rice bran is the pericarp or bran layer of the rice with only such quantity of hull fragments as is unavoidable in the regular milling of rice.

"Rice hulls are the outer coverings of the rice.

"Rice polish is the finely powdered material obtained in polishing the kernel.

"Rice meal is ground brown rice or ground rice after the hull has been removed.

"Ground rough rice is ground rice from which the hull has not been removed or ground paddy rice.

"Rice Stone bran is the siftings from the materials secured in removing hulls from rice and contains rice germs, broken rice and some rice hulls.

"Rice huller bran is a product secured by the huller and comes from brown rice and consists mostly of the bran and germs."

Wise (1927) in a pamphlet published by the Rice Miller's Association defines **Brewer's Rice** as "... the finely broken particles of milled rice It is secured from screening out the very finely broken grits from the milled rice and has approximately the same chemical composition as milled rice."

These definitions describe the respective rice by-products as used in this study.

PREVIOUS INVESTIGATIONS

Composition and Analyses of Rice By-products

Early work concerning the composition and feeding value of rice by-products was published by Browne (1903) and (1904) and by Rose (1889) at this station.

Reed and Liepsner (1917) give a description of the rice milling process, list analyses made of rice products, and tabulate the yield of by-products and cleaned rice obtained in rather extensive tests made on products from about two dozen mills.

LeClerc (1932) calls attention to the fact that important vitamin and mineral elements are removed in the milling of brown rice. He states, "... more than 50% of the ash of rice is a combination of phosphorus with calcium, potassium, magnesium, and sodium; fully 25% of it being in the form of potassium phosphate." These elements are incorporated in the rice bran and rice polish which are used as feed for livestock.

Evans and Burr (1928) reported tikitiki, an alcoholic extract of rice polishings, to be a potent source of vitamin B, but low in vitamin G, however, Hetler, Meyer, and Hussemann (1931) found an appreciable amount of vitamin G, to be present in tikitiki. These same workers determined the presence of both vitamins B and G in rice polishings.

Smith (1929) rates rice polishings and unpolished brown rice as good sources of vitamin B (complex) and as containing some vitamin A. Polished rice on the other hand contains no Vitamin A, B (complex) nor C.*

Osborne and co-workers (1915) present interesting conclusions concerning the amino acid content of the rice kernel. To quote, "Compared with the endosperm proteins of wheat and maize, the protein of rice yields relatively much of each of the basic amino acids, arginin, histidin and lysin and comparatively little ammonia and nonamino nitrogen. In its general amino acid make-up it more nearly resembles the majority of the proteins of animal tissues than do the proteins of maize or wheat. This may explain the extensive use of rice as an almost exclusive diet in spite of its low protein content."

Fraps (1916) presents analyses of rice and rice products and discusses the feeding value of these products. He concludes that rice products compare favorably in feeding value with corn.

Fraps (1928) reports the results of 63 digestion experiments on poultry in some of which rice products were tested. He also has compiled, "... all other digestion experiments on poultry that could be found."

In tables 1 and 2 are presented digestion coefficients and average composition and productive values of certain common poultry feeds, as given in this bulletin. The digestion coefficient of wheat middlings is taken from Kaupp and Ivey (1923).

* Since preparation of the manuscript for this bulletin, M. A. Jull, in Vol. 39 pp. 23-27, 56-63, of the U. S. Egg and Poultry magazine, presents the following conclusions: "As a supplement, rice polish was found to be fully twice as potent in Vitamin B as a commercial yeast product used in animal feeding. Both rice-bran and rice-polish increased the Vitamin B content of the eggs to high levels."

TABLE 1
DIGESTION COEFFICIENTS OF POULTRY FEEDS*

	No. of Trials	Protein	Ether Extract	Crude Fiber	Nitrogen- free Extract
Corn	24	74.9	85.1	14.8	90.1
Wheat	34	74.0	47.1	8.7	88.9
Oats (whole)	21	74.1	81.7	7.1	69.3
Rice, rough	10	74.2	72.2	5.1	83.8
Corn meal	11	71.8	91.6	15.2	91.9
Rice Polish	4	80.9	94.8	4.3	89.3
Wheat gray shorts.....	4	69.2	85.2	13.0	71.0
†Wheat middlings (N.C.).	18	64.5	53.6	8.4	54.8
Wheat bran	11	59.9	50.0	7.9	54.1
Rice bran	9	57.9	87.1	3.0	52.3

* Taken from Table 8, Bul. 372 Texas Agr. Exp. Station. Although taken from the Texas bulletin, not all of the tests were made at that station.

† Taken from Table 8, Tech. Bul. No. 22, North Carolina Agr. Exp. Station.

TABLE 2
AVERAGE COMPOSITION AND PRODUCTIVE VALUES OF CERTAIN POULTRY FEEDS*

	Protein	Ether Extract	Crude Fiber	Nitrogen- free Extract	Water	Ash	Productive Energy	Digestible Protein
Corn	10.0	3.8	2.3	71.0	11.3	1.6	83.5	7.5
Wheat	12.3	1.8	2.4	71.1	10.6	1.8	78.9	9.1
Oats (whole)	12.2	4.7	11.5	59.1	8.7	3.8	61.8	9.0
Rice, rough or unhulled	8.1	1.8	8.9	64.5	11.7	5.0	66.9	6.0
Rice, clean and polished	8.7	0.4	0.4	77.4	12.4	0.7	88.5	6.9
Corn feed meal	10.2	4.1	2.9	71.0	10.2	1.6	85.8	7.3
Rice polish	12.8	11.6	3.2	58.0	8.5	5.9	94.4	10.4
Wheat gray shorts....	18.0	4.5	5.8	57.0	10.4	4.3	59.0	12.5
Wheat brown shorts..	18.5	4.8	6.3	55.5	10.3	4.6	38.5	9.3
Wheat bran	16.8	4.3	9.4	53.5	9.7	6.3	38.5	10.1
Rice bran	12.8	12.5	12.1	43.4	8.6	10.6	54.0	7.4

* Taken from Table 7, Bul. 372, Texas Agr. Exp. Station.

† This may also be used as the composition of "brewer's rice."

Smith's results (1930 A) (1930 B) and (1931) all support the statement made in (1930 B) that, "rice feeds cause a decrease in hatchability with or without cod liver oil supplement."

These results indicate in general that the various rice by-products may be used successfully in rations for poultry, but that they must be used intelligently if best results are to be obtained.

MATERIALS AND METHODS

This series of experiments began November 1, 1927, and terminated July 31, 1932. The first test extended over a 6 month period, the second continued for 10 months in 1928-1929, the third for 11 months in 1929-30, the fourth for 10 months in 1930-31, and the fifth for 10 months in 1931-32. The first two tests were started on November 1, the last three on October 1.

Single Comb White Leghorn pullets of similar breeding, pedigree hatched, chiefly in February, March or April, were used in all experiments. Ten pullets were placed in each lot in 1927, 16 per lot in 1928, 25 per lot in 1929, 24 per lot in 1930 and 25 per lot in 1931. The pullets were trapnested throughout each test and only eggs laid in trapnests were considered in calculating egg production. Allotment was made for the first four tests upon the basis of body weight together with general considerations of vigor, type, etc. For the fifth year in addition to the above considerations pedigree was taken into account by dispersing full sisters and half sisters into the various lots.

During the first two years each lot was housed in one-half of an 8' x 12' open front colony house with a single yard 40' x 60'. For the third and fourth years each lot was kept in an 8' x 12' open front colony house, with access to double yards, each 40' x 60'. For the last test, the lots were housed, each in one-section (12' x 18') of a multi-unit laying house. Double yards each 12' x 75' were alternated for each lot.

All-night lights were furnished to all lots during 1931-32 (fifth experiment).

Green feed comprised of sudan grass, soybeans, white clover, colards, oats or rye grass was grown in all yards, or was fed daily as cut green feed. The birds had access to the yards daily after about 10 a. m. throughout the year, except during brief periods of inclement weather.

The rations were fed as mash (in hoppers) and grain (trough fed) for the first two years. Thereafter all lots were fed by the all-mash method since control of the diet is much simpler by this method.

The rations used throughout this series of experiments are given in table 4. Each ingredient is given as a percentage of the total ration consumed (exclusive of green feed, water, oyster shell, and grit). Since the grain and mash method of feeding was used during 1927-28 and

TABLE 4
RATIONS USED

Ingredients Listed with Amounts, as Per

	1927-28							1928-29								
	Lots							Lots								
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9
Untreated Rice Bran.....		6.0	....	8.0	....	8.0	6.0	....	8.6	....	6.9	7.8	....	....	7.8	....
Treated Rice Bran .....		....	....	....	....	....	....	....	....	....	....	....	....	....	....	10.4
Rice Polish .....		....	8.0	8.0	8.0	....	6.0	....	....	11.6	10.4	11.6	....	....	27.5	30.0
Brewers' Rice .....		....	....	....	18.0	18.0	22.0	....	....	....	....	55.0	24.0	40.0	....	....
Rough Rice .....		....	....	....	....	....	....	....	....	....	....	....	....	....	11.6	10.4
Yellow Corn Meal	7.2	6.0	8.0	8.0	8.0	8.0	6.0	13.0	13.0	11.6	10.4	11.6	10.4	13.0	....	6.9
Wheat Bran	7.2	....	8.0	....	8.0	....	....	8.6	....	7.8	....	....	6.9	8.6	....	....
Wheat Shorts	7.2	6.0	8.0	8.0	8.0	8.0	6.0	13.0	13.0	....	....	....	10.4	13.0	11.6	....
Pulverized Oats (Whole)..	7.2	6.0	....	....	....	8.0	....	....	....	....	....	....	....	....	....	6.9
Meat Scraps	7.2	6.0	8.0	8.0	8.0	8.0	6.0	8.6	8.6	7.8	6.9	7.8	6.9	8.6	7.8	....
Dried Buttermilk .....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Shrimp Meal .....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Alfalfa Leaf Meal.....	3.6	3.0	4.0	4.0	4.0	4.0	3.0	4.3	4.3	3.9	3.4	3.9	3.4	4.3	3.9	3.4
Mineral Mixture	0.4	0.3	0.4	0.4	0.4	0.4	0.3	2.5	2.5	2.3	2.0	2.3	2.0	2.5	2.3	2.0
Whole Oats (S. Grain)....	....	....	....	....	....	....	....	10.0	10.0	11.0	12.0	....	12.0	10.0	22.0	....
Cracked Yellow Corn	40.0	44.5	37.6	37.6	37.6	37.6	44.7	40.0	40.0	44.0	48.0	....	24.0	....	....	....
Whole Wheat	20.0	22.2	18.0	18.0	....	....	....	....	....	....	....	....	....	....	....	....
Percentage Total of Rice Products	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	0.0	6.0	8.0	16.0	26.0	26.0	34.0	0.0	8.6	11.6	17.3	74.4	24.0	40.0	35.3	40.4

Mineral Mixture Salt only (NaCl)
with oyster shell and
grit fed ad libitum

* The majority of the birds in this lot were stolen early in the year,
consequently the lot was discontinued.

Bone meal 50%
Ground Oyster Shell.. 33.3%
Salt (NaCl) 16.7%
With oyster shell and
grit ad libitum

Cent of Total Ration

10*	1929-30						1930-31					1931-32				
	Lots						Lots					Lots				
	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5
8.6	....	....	....	10.0	20.0	....	....	10.0	10.0	20.0	20.0	....	....	....	12.0	....
13.0	....	....	....	....	....	....	....	....	....	....	....	12.0	12.0	12.0	....	24.0
25.0	....	....	....	10.0	....	20.0	....	....	....	....	....	12.0	....	12.0	12.0	....
....	....	....	40.0	....	....	....	....	....	....	....	....	....	24.0	....	....	....
....	....	40.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13.0	50.0	10.0	10.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	30.0	50.0	38.0	50.0	50.0	50.0
....	10.0	10.0	10.0	....	....	....	10.0	....	10.0	....	10.0	....	....	....	....	....
....	10.0	10.0	10.0	....	....	....	....	....	....	....	....	....	....	....	....	....
....	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	....	....	10.0	....	....	....	....	....
8.6	10.0	10.0	10.0	10.0	10.0	10.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	....	15.0	15.0
....	....	....	....	....	....	....	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
....	....	....	....	....	....	....	....	....	....	....	....	....	....	15.0	....	....
4.3	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	3.0	3.0	3.0	3.0	3.0
2.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	3.0	3.0	3.0	3.0	3.0
5.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20.0	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
46.6	0.0	40.0	40.0	20.0	20.0	20.0	0.0	10.0	10.0	20.0	20.0	24.0	36.0	24.0	24.0	24.0

Bone Meal 30%
 Gr. Oyster Shell..... 60%
 Salt (NaCl) 10%
 With oyster shell and
 grit ad libitum.

To March 1

After March 1

Bone Meal 10%
 Gr. Oyster
 Shell 80%
 Salt (NaCl).. 10%
 With oyster shell and
 grit ad libitum.

....
 90%
 10%

Bone Meal 30%
 Ground Oyster Shell..... 60%
 Salt (NaCl) 10%
 With oyster shell and
 grit ad libitum.

1928-29 the percentages for these years are based upon the average consumption of mash and grain for each lot for the year. For the remaining experiments, the percentages are those of the respective all-mash rations.

Small lots of eggs from each pen were placed in storage during the spring seasons of 1929, 1930, and 1931. The eggs were held in storage for approximately 200 days each season and were graded individually at the beginning, at about the middle, and at the end of the storage season.

No egg weights were recorded during the first year, but thereafter all eggs laid during the first five days of each month were weighed individually in grams on special egg scales. Monthly averages were determined for each hen for all months in which three or more eggs were weighed and the mean yearly egg weight for each hen calculated from the monthly averages.

The birds were weighed individually on the first of each month and the mean yearly body weight of each bird determined from the monthly weights.

In the spring of 1929 chicks were hatched from a representative number of hens in each lot. The chicks were fed the same ration and brooded together and the rate of growth recorded.

Costs of the various rations and the value of the eggs produced are not considered since figures applicable at one time and (or) place are of no value at another time and (or) place.

A number of changes in management were made from year to year; such as method of feeding, date of starting the test, number of birds per lot and duration of the test. The changes make the direct comparison of the results of one year with those of another somewhat difficult. For this reason, where feasible, the data have been converted to a percentage basis.

It is customary to start feeding experiments on a given calendar date and terminate them on a later arbitrary date. There is no adequate biological basis for this method of procedure. Biologically we know that birds normally start laying at different dates and ages and persist in production, due to genetic and environmental conditions quite aside from the diet received. Because of these conditions a somewhat different method was used in analyzing the data of this series of experiments. The data for each individual pullet were placed on a "holiroth" card, for convenience in computation. By considering the data in this way it is possible to consider the actual time each pullet was in production. The method used to determine the "days in production" for each bird was as follows: The experimental laying year started on the day the bird laid her first egg after being on the experimental ration; the experimental laying year ended for any given individual ten days after the last egg was laid, regardless of when

this occurred during the experimental year. If the bird laid up to within the last ten days of the experimental year her laying year ended with the experiment.

A bird was considered out of the experiment for such periods as she was broody or sick and out of pen. The justification for such a method is based upon the probable fact that a hen is much more likely to stop laying due to causes other than the ration fed (when only probably "adequate" rations are used) than because of the difference in diets. On the other hand if a ration were of such quality as to cause a large percentage of the hens in the lot to stop laying early in the year, this would be made evident by a decidedly lower average "days in production" for the lot as a whole.

The results obtained by treating the data in this way were compared to figures secured by the common method of basing the comparisons upon a given number of birds in each lot for a definite number of months. In general the two methods yielded similar results.

This method of arranging the data also makes it possible to consider birds that have made a creditable record for a portion of the year, but are out of the lot before the end of the experimental period. For example, birds that are stolen, accidentally killed, disappear, etc., may be included. It also permits the omission of such birds as obviously have not produced normally. Birds were omitted unless they were in production for at least approximately two months, also eliminated were birds with records so low (examples 31 eggs in 175 days, 26 eggs in 170 days) that it is hardly conceivable that feed was the limiting factor.

Feed consumption figures for each pen are necessarily based upon the actual number of birds in the pen from month to month.

DATA AND DISCUSSION

Summarized data for the five year's work are given, by lots, in Table 5. The amount and kind of rice product in the rations, egg records, hatching records, egg weights, body weights, percentage of birds with records and percent of the birds in the lots at the end of the experiment, are given in this table.

Winter Egg Production

The "winter" season started one month earlier for the last three years of the experiment, therefore it is not fair to make a direct comparison of the number of winter eggs produced the first two years with that of the later years. Comparison of lots within the year are valid, however, for all years. Lot 3 (8% rice polish) yielded the best winter egg-production in 1927-28 although not significantly higher than that of Lot 2 (6% rice bran). The check lot produced a large number of floor eggs which, if disregarded, places the production at a low

Rice in Ration	Lot No.	No. of Individuals	Average No. Winter Eggs		
				Std. Dev. Mean	
None— Check or basal ration.....	1	7	20.3	7.2	5
6% Untreated rice bran	2	7	43.1	6.1	6
8% Rice polish	3	8	51.9	5.4	9
8% Untreated rice bran }	4	8	41.4	6.8	6
8% Rice polish }					
8% Rice polish }					
18% Brewers' rice }	5	4	25.0	9.0	3
8% Untreated rice bran }					
18% Brewers' rice }	6	7	35.4	7.8	6
6% Untreated rice bran }					
6% Rice polish & 22% brewers' rice }	7	5	29.8	8.9	5
Average all birds 1927-28....	..	46	36.7	....	6
None— Check or basal ration.....	1	12	36.0	6.3	10
8.6% Untreated rice bran.....	2	13	33.6	5.4	9
11.6% Rice polish	3	12	41.5	4.7	11
6.9% Untreated rice bran }	4	12	37.5	4.3	11
10.4% Rice polish }					
7.8% Untreated rice bran, }					
11.6% Rice polish, and 55% brewers' }	5	8	34.1	3.5	10
rice }					
24.0% Brewers' rice	6	11	37.8	5.8	10
40.0% Brewers' rice	7	12	40.6	5.2	10
7.8% Untreated rice bran and }	8	12	36.2	4.4	9
27.5% Brewers' rice }					
10.4% Rice polish }					
30.0% Brewers' rice }	9	6	32.8	2.2	7
Average all birds 1928-29....	..	98	37.0	....	10
None— Check or basal ration.....	1	23	33.6	3.6	9
40% Rough rice (ground).....	2	19	32.9	3.5	9
40% Brewers' rice	3	14	29.4	3.2	8
10% Untreated rice bran and }	4	12	46.3	5.4	11
10% Rice polish }					
20% Untreated rice bran.....	5	14	40.2	4.4	10
20% Rice polish	6	13	28.5	4.7	10
Average all birds 1929-30....	..	95	34.7	....	9
None— Check or basal ration.....	1	18	51.5	6.0	10
10% Untreated rice bran (replaced wheat bran).....	2	12	43.4	4.4	10
10% Untreated rice bran (replaced ground oats).....	3	12	47.8	5.0	10
20% Untreated rice bran (replaced both wheat bran and gr. oats).	4	16	51.3	4.8	10
20% Untreated rice bran (replaced 20% corn meal).....	5	14	55.0	6.9	10
Average all birds 1930-31....	..	72	50.2	....	10
12% Treated rice bran }	1	19	67.1	5.4	12
12% Rice polish—check ration }					
24% Treated rice bran }	2	19	61.6	4.4	11
12% Brewers' rice }					
12% Treated rice bran }	3	18	60.2	5.7	9
12% Rice polish (with shrimp meal }					
as protein supplement }					
2% Untreated rice bran }	4	20	51.7	6.0	9
2% Rice polish }					
4% Treated rice bran.....	5	18	62.9	5.2	10
Average all birds 1931-32....	..	94	60.6	....	10
Average all birds—all years..	..	404	44.3	....	19
Per cent					

* Per cent hatched of fertile eggs.

* Many "floor" eggs were produced in the early months of this test. For exam

TABLE 5

RICE BY-PRODUCTS FOR LAYING HENS

Data Given by Lots and Years

Data Given by Lots and Years															
EGG RECORD					HATCHING RECORD					Average Eggs Weight (grams)		Average Body Weight (grams)		Per Cent of Birds with Records	Per Cent with Records, in Lot at end of Exp.
Average No. Eggs for Exptl. Period	Days in Production	Per Cent Prod. for Exptl. Period	No. Eggs Set Per Hen	Average Per Cent Fertility	Average Per Cent Hatched*										
1927-28 Mash and Grain Method—Year Started November 1															
	Std. Dev. Mean		Std. Dev. Mean				Std. Dev. Mean								
3	7.6	150.9	19.3	33.3‡	....	.....	.....	.....	.....	.....	1666	59.6	70.0	71.4	
6	3.3	153.1	17.8	43.5	....	.....	.....	.....	.....	.....	1464	40.7	70.0	100.0	
1	7.2	173.5	3.8	51.9	....	.....	.....	.....	.....	.....	1508	54.2	80.0	100.0	
5	10.4	165.8	6.0	40.7	....	.....	.....	.....	.....	.....	1459	60.8	80.0	87.5	
0	11.6	129.5	31.7	27.8	....	.....	.....	.....	.....	.....	1418	73.0	40.0	75.0	
9	12.6	158.4	12.9	39.7	....	.....	.....	.....	.....	.....	1497	91.9	70.0	100.0	
2	11.0	154.4	12.9	32.5	....	.....	.....	.....	.....	.....	1394	87.5	50.0	80.0	
3	....	157.4	....	40.2	....	.....	.....	.....	.....	.....	1495	....	67.2	89.1	
1928-29 Mash and Grain Method—Year Started November 1															
2	6.4	245.9	21.5	44.4	11.0	92.8	8.6	50.6	8.1	53.2	1.1	1563	41.4	75.0	91.7
5	9.3	259.6	9.9	35.6	11.1	92.4	4.4	56.8	10.1	54.4	0.9	1638	59.0	81.2	84.6
5	13.8	268.6	13.5	41.9	11.1	96.9	3.1	50.9	4.7	53.3	1.1	1585	64.5	75.0	91.7
9	17.3	241.3	23.7	48.0	11.4	84.9	9.1	60.8	7.8	52.2	0.9	1672	70.2	75.0	83.3
0	10.5	270.5	10.2	40.3	11.8	93.2	12.2	76.5	11.8	52.4	1.6	1629	100.3	50.0	100.0
6	12.6	245.4	17.2	41.0	11.6	96.6	1.1	43.2	6.6	53.5	1.5	1597	92.8	68.8	90.9
2	13.8	243.7	19.6	43.6	11.1	91.8	4.2	53.0	8.5	52.8	0.9	1620	48.0	75.0	83.3
2	13.9	223.0	18.5	41.8	10.5	100.0	11.1	72.2	9.0	50.2	0.9	1502	56.8	75.0	83.3
8	10.7	238.2	30.4	32.7	11.5	91.2	11.5	63.8	7.9	52.8	1.6	1417	63.9	37.5	100.0
0	....	248.3	....	41.5	11.2	92.8	....	56.6	....	52.8	....	1589	....	70.8	88.8
1929-30 All-Mash Method—Year Started October 1															
9	9.8	217.6	14.4	42.7	27.2	73.6	7.8	65.8	15.0	52.8	0.7	1412	39.4	92.0	65.2
9	9.1	228.3	13.4	40.7	32.2	89.4	8.7	58.5	6.4	53.0	0.9	1347	42.1	76.0	73.7
7	10.9	192.1	16.9	43.6	31.7	86.2	8.6	67.3	7.1	53.1	0.8	1372	33.9	56.0	78.6
2	11.3	263.3	21.4	43.4	37.1	71.4	8.4	79.3	3.4	54.2	0.8	1536	66.6	48.0	75.0
8	14.8	218.9	27.9	48.3	38.4	89.8	12.8	78.0	10.3	53.5	5.8	1394	30.7	56.0	78.6
6	13.0	211.8	23.4	48.0	31.2	96.9	10.2	75.0	8.5	53.9	1.2	1398	52.7	52.0	84.6
3	....	221.1	....	44.0	32.7	83.8	....	70.3	....	53.3	....	1404	....	67.2	74.7
1930-31 All-Mash Method—Year Started October 1															
2	9.4	212.6	13.0	49.0	29.5	55.5	7.2	55.7	6.0	54.1	1.1	1431	32.4	75.0	66.7
2	11.2	212.5	17.4	47.2	29.5	70.4	9.8	67.7	9.2	51.1	0.9	1413	33.0	50.0	66.7
9	10.0	211.3	15.2	51.1	31.3	69.0	6.0	71.3	8.4	52.9	0.8	1368	28.0	50.0	66.7
4	11.8	215.2	16.0	47.6	32.4	75.3	8.1	80.2	7.2	54.2	0.7	1459	28.5	66.7	68.8
5	13.0	216.3	15.1	47.4	28.4	81.3	8.7	55.4	8.2	51.2	1.0	1402	46.5	58.3	42.9
4	....	217.8	....	48.4	30.6	68.5	....	65.1	....	52.8	....	1418	....	61.6	62.5
1931-32 All-Mash Method—Year Started October 1—All Night Lights Throughout															
8	10.3	263.4	13.0	47.8	7.8	85.7	9.9	70.8	9.4	54.3	0.7	1533	35.4	76.0	84.2
6	9.4	255.2	11.7	44.1	8.8	60.7	8.1	71.0	8.6	55.3	0.9	1589	35.1	76.0	84.2
9	9.9	234.4	19.3	42.6	8.0	77.4	10.9	77.4	10.5	53.9	0.6	1565	45.5	72.0	72.2
0	10.7	222.3	17.7	41.8	10.2	73.0	8.2	47.9	7.2	54.0	0.6	1521	41.0	80.0	80.0
2	10.0	225.1	18.3	45.8	9.9	77.3	9.4	32.8	6.4	55.1	0.8	1598	33.2	72.0	83.3
9	....	240.1	....	44.5	9.0	75.4	....	58.2	....	54.5	....	1560	....	75.3	80.8
4	....	224.9	....	43.8	21.7	80.6	....	63.0	....	53.4	....	1502	....	69.3	79.2

the per cent production for Lot 1 for the experimental period is 47% when "floor" eggs are included.

figure; however, when they are included the production of this pen is approximately equal to that of the other lots. Lot 5 (with a total of 26% rice products) and Lot 7 (34% rice products) gave the lowest winter production for the first year.

The winter production of all lots in 1928-29 were practically equal although the difference in average production of 8.7 eggs between the highest lot (No. 3—11.6% rice polish) and the lowest lot (No. 9—40.4% rice products) might indicate a real difference.

The highest winter egg record in 1929-30 was made by Lot 4 birds which were fed a ration containing 10% rice bran and 10% rice polish, and the lowest record was made by Lot 6, in which case 20% rice polish was fed. Lot 3 (40% brewer's rice) also averaged low in winter egg-production with the other lots ranking in intermediate positions.

The winter egg production of all lots in 1930-31 was uniformly better than in previous years with no appreciable differences indicated between lots.

Rice bran and rice polish were incorporated in the check ration in 1931-32. A decided improvement in average winter egg yield was obtained this year over that of previous years. This is attributed chiefly to the use of all-night lights in all pens. Very little difference was obtained in the winter egg production of the lots except in Lot 4 (12% untreated rice bran plus 12% rice polish) in which case it was somewhat lower.

No rice product or combination of rice products used produced outstandingly superior or inferior results. The rations containing rice by-products, in general, compared favorably with the check rations in the production of winter eggs.

Average Egg-Production for the Experimental Year

The average egg production for the experimental year is given both as number of eggs and as per-cent production. The latter figure is used in discussing the results because it places the results of all years on a directly comparable basis.

The birds of Lot 3 (8% rice polish) averaged appreciably higher in egg-production for the year than did those of any other lot in 1927-28. Lot 5 (8% rice polish and 18% brewer's rice) and Lot 7 (34% total rice products) yielded decidedly inferior production. The other lots averaged about midway between the high lot and the low lots.

The highest production in 1928-29 was obtained in Lot 4 (6.9% rice bran and 10.4% rice polish), while the lowest production was secured in lot 9 (10.4% rice polish and 30% brewer's rice). Production was intermediate and practically equal in the other lots.

The percent production for the several lots within the respective years did not differ one from the other for all practical purposes during 1929-30, 1930-31 or 1931-32.

Considering the year as a unit, the highest per cent production was obtained during 1930-31, with 48.4%; second in rank is 1929-30, with 44.0%; third 1931-32, with 43.8%; fourth 1928-29 with 41.5%; and last 1927-28, with 40.2% production. The results are fairly uniform within the various years and from year to year. As a whole the birds on diets containing rice products produced as well as those on the check ration and no rice product as used proved to be harmful to egg production.

Length of Productive Period

The average number of "days in production" might be considered as another measure of the efficiency of the rations used. Birds fed a decidedly superior ration might be expected to remain in production longer than birds on a markedly inferior diet. In 1927-28 the difference between the longest period of production, Lot 3 (173 days) and the shortest productive period, Lot 5 (129.5) days was 43.5 days with a Standard deviation of the difference of 31.9. By applying the "t" test, Wallace and Snedecor (1931), it was determined that this is only a random difference and indicates that no sensible difference existed in length of productive period.

Similar tests of the difference between the high lot and low lot for each year reveal that in no case was the difference of a high order of significance, although in one case it was possibly so. This instance was in 1929-30, in which the difference was 71.2 days with a standard deviation of the difference of 27.3. The lot with the longest productive period in 1929-30 (No. 4) received a ration containing 10% rice bran and 10% rice polish. Lot 3 had the shortest productive period for the year on a ration containing 40% brewer's rice.

Hatching Record

No hatching record was kept for the 1927 season. Fertility was satisfactory in all lots during 1928-29 but during the last three years it was quite low in some lots. This is attributed to the individuality of the male mated to a given pen rather than to the ration fed.

In 1928-29 the highest hatchability was obtained in Lot 5, in which 74.4% of the total ration was rice products, with 76.5% of fertile eggs hatched. This was followed closely by Lot 8 (35.3% rice products) with 72.2%. The lowest per cent hatch was in Lot 6 (24% brewer's rice with 43.2%. The difference in hatchability of the high lot and low lots falls within the range of possible significance, i. e., a probability of between .05 and .01. Likewise in 1929-30 the difference in hatchability between the high lot (10% rice bran plus 10% rice polish) with 79.3% and the low lot No. 2 (40% ground rough rice) with 58.5% is possibly significant but not highly so.

Lot 4 (20% rice bran) yielded best hatching results in 1930-31 with 80.2% hatched. Lot 5 (20% rice bran replacing yellow corn meal) with 55.4% hatched and Lot 1 (no rice products) with 55.7% hatched, were lowest in hatchability for this year. The differences between the high lot and each of the low lots again fall short of being highly significant but are possibly so.

The difference in hatchability of 44.6% between Lot 3 (12% treated rice bran and 12% rice polish) and Lot 5 (24% treated rice bran) for 1931-32, is great enough that the probability of obtaining such a difference at random is less than .01 and it may be considered as a real difference. It is doubtful that this difference is due altogether to the rations fed although the diets probably had a bearing upon the hatchability. The hatchability of Lot 4 (12% untreated rice bran and 12% rice polish) was also possibly significantly lower than that of lot 3.

For the series of experiments as a whole no consistent, significant differences in hatchability were associated with any rice product or combination of products. The rations containing rice products compare favorably in hatching results with the check rations. These results are contrary to the conclusion reached by Smith (1930 B).

Egg Size

No eggs were weighed in the first experiment. The average egg weight was significantly heavier (for 1928-29) in Lot 2 (8.6% rice bran) than that for Lot 8 (7.8% rice bran and 27.5% brewer's rice). The Lot 2 eggs were also possibly significantly heavier than those of Lot 4 (6.9% rice bran and 10.4% rice polish).

The egg weights of all lots were essentially uniform in 1929-30. In 1930-31 Lot 1 (no rice products) and Lot 4 (20% rice bran) produced eggs that on the average are possibly heavier than those of Lot 2 (10% rice bran) and Lot 5 (20% rice bran).

The average egg weights of the five lots in 1931-32 are remarkably uniform, the largest difference being only 1.4 grams.

No definite association was found between the various rations used and egg weight. This same tendency was found in Smith's (loc. cit.) work.

Body Weight

The mean yearly body weight of the check lot of 1927-28 was greater than that for any other lot. No significant difference existed between the other six lots.

Lot 4 (6.9% rice bran and 10.4% rice polish) averaged heaviest in weight and Lot 8 (35.3% rice products) and Lot 9 (40.4% rice products) averaged smallest in size during the second experiment. The other lots were intermediate in weight with no real differences between them.

TABLE 7
COMPARISON OF HENS THAT DIED DURING YEAR TO THOSE THAT LIVED THROUGHOUT THE YEAR

Disposal	No. Individuals	Egg Production				Hatching Record			Egg Weight grams	Body Weight grams
		Winter Eggs	Total for Exptl. Period	Average No. of Days in Prod.	Per Cent Prod.	Average No. of Eggs Set per Hen	Per Cent Fertile	Per Cent Hatch		
Died During Year.....	85	43.3	66.9	162.0	41.3	13.6	59.4	46.2	51.8	1459
Lived Throughout Year.....	307	44.9	108.8	245.6	44.3	17.5	73.4	56.6	53.9	1519

Feed Consumption and the Comparative Efficiency of the Rations

The average feed consumption per bird for the experimental year and the comparative efficiency of the several rations as measured by pounds of feed per dozen eggs, and conversely by number of eggs per pound of feed, are presented in table 8. The kind and amount of rice products in each ration are also given. The figures cannot be considered as absolutely accurate because hopper feeding inevitably entails some wastage. Feed consumed by rats is also a possible variable. Another possible factor is the mortality of hens during different parts of the month and the subsequent computation of feed consumption on the basis of average number of hens in the pen for the month. But making due allowance for these variables, the comparative efficiency of the rations is probably indicated by the figures given.

During the first year of the test lot 3 (8% rice polish) and lot 4 (8% untreated rice bran and 8% rice polish) were the most efficient rations used. Lot 7 (with 34.0% total rice products) was lowest in efficiency, although the birds of this lot consumed less feed than any other lot.

In 1928-29 lot 9 ration, containing 10.4% rice polish and 30% brewer's rice, was the least efficient (9.53 lbs. feed per dozen eggs) and lot 4 ration, with 6.9% rice bran (untreated) and 10.4% rice polish, was highest in efficiency (5.04 lbs. feed per dozen eggs). The other lots, including the check lot were uniform and were intermediate in efficiency.

During 1929-30 no appreciable differences in efficiency of the rations were evident.

Lot 2 (10% rice bran) ranked lowest in efficiency for 1930-31, but the results of the other lots were not greatly superior and were practically equal one to the other.

The check ration showed highest efficiency for 1931-32 and lot 3 (same as check ration except shrimp meal replaced meatscrap) yielded poorest results.

Considering the entire series of experiments, the rations containing rice by-products gave satisfactory efficiency as compared to the check rations.

COMPARISON OF RATIONS—GROUPED BY AMOUNT AND KIND OF RICE BY-PRODUCTS CONTAINED.

In Table 9 a comparison is made of the rations, in which the lots are grouped; first by per cent total rice products in the ration, second by per cent untreated rice bran in the ration, third by per cent treated (see explanation below) rice bran in the ration, fourth by per cent brewer's rice in the ration, and fifth by per cent rice polish in the ration.

TABLE 8

FEED CONSUMPTION AND COMPARATIVE EFFICIENCY OF RATIONS

Lot and Year	Per Cent Rice Products in Rations							Total Feed per Bird for Expt'l Period (Lbs.)	Duration of Expt'l Period (Months)	Pounds of Feed per Dozen Eggs	Number of Eggs per Lb. of Feed
	Rice in Check Ration	Untreated Rice Bran	Treated Rice Bran	Rice Polish	Brewers' Rice	Rough Rice	Total Rice Products				
1927-28—1	0.0	....	....	....	....	....	0.0	36.9	6	4.95	2.4
2	6.0	....	....	....	....	6.0	36.3	6	6.75	1.8
3	8.0	....	....	8.0	28.7	6	3.96	3.0
4	8.0	....	8.0	....	....	16.0	32.7	6	4.18	2.9
5	8.0	18.0	....	26.0	36.4	6	6.66	1.8
6	8.0	....	....	18.0	....	26.0	29.7	6	6.21	1.9
7	6.0	....	6.0	22.0	....	34.0	25.8	6	8.45	1.4
1928-29—1	0.0	....	....	....	....	....	0.0	60.6	10	5.84	2.1
2	8.6	....	....	....	....	8.6	62.6	10	6.66	1.8
3	11.6	....	....	11.6	58.4	10	6.56	1.8
4	6.9	....	10.4	....	....	17.3	60.1	10	5.04	2.4
5	7.8	....	11.6	55.0	....	74.4	51.9	10	7.55	1.6
6	24.0	....	24.0	60.1	10	7.26	1.6
7	40.0	....	40.0	63.3	10	6.48	1.8
8	7.8	....	....	27.5	....	35.3	65.0	10	6.07	2.0
9	10.4	30.0	....	40.4	54.5	10	9.53	1.3
1929-30—1	0.0	....	....	....	....	....	0.0	58.8	11	7.02	1.7
2	40.0	40.0	63.6	11	7.98	1.5
3	40.0	....	40.0	71.0	11	8.70	1.4
4	10.0	....	10.0	....	....	20.0	62.2	11	7.74	1.6
5	20.0	....	....	....	....	20.0	69.6	11	7.07	1.7
6	20.0	....	....	20.0	68.8	11	7.94	1.5
1930-31—1	0.0	....	....	....	....	....	0.0	60.2	10	6.22	1.9
2	10.0	(replaced wheat bran)				10.0	53.6	10	7.71	1.6
3	10.0	(replaced ground oats)				10.0	62.0	10	7.05	1.7
4	20.0	(replaced wheat bran and ground oats)				20.0	57.1	10	7.04	1.7
5	20.0	(replaced 20% Yellow corn meal)				20.0	51.4	10	6.28	1.9
1931-32—1	12.0	12.0	....	....	24.0	52.2	10	4.78	2.5
2	12.0	....	24.0	....	36.0	51.9	10	5.63	2.1
3	12.0	12.0	(protein supplement shrimp meal)		24.0	62.4	10	7.10	1.7
4	12.0	....	12.0	....	....	24.0	49.4	10	6.40	1.9
5	24.0	....	....	....	24.0	52.3	10	5.79	2.1

COMPARISON OF RATIONS—GROUPED

		EGG RECORD	
Percentage Rice Products in Ration	No. of Individuals	Average No. Winter Eggs	Average No. Eggs for Exptl. Period
Grouped by			
No Rice Products (4 lots).....	60	37.9	94.6
6, 8, 8.6 and 10% (5 lots).....	52	43.2	94.0
11.6, 16 and 17.3% (3 lots).....	32	40.0	102.5
20% (5 lots)	69	44.6	105.0
24 and 26% (7 lots).....	97	54.5	98.9
34, 35.3 and 36% (3 lots).....	36	48.7	97.5
40 and 40.4% (4 lots).....	51	33.8	91.8
74.4% (1 lot)	8	34.1	109.0
All birds all years.....	404	44.3	98.4
Grouped by			
No Rice Products (4 lots).....	60	37.9	94.6
Total—all lots not getting untreated			
Rice Bran	232	45.1	99.9
6, 6.9, 7.8, 8.0 and 8.6% (8 lots).....	72	36.4	87.2
10 and 12% (4 lots).....	56	47.9	102.3
20% (3 lots)	44	49.0	103.5
Grouped by			
No Rice Products (4 lots).....	60	37.9	94.6
Total—All lots not getting Treated			
Rice Bran	330	39.9	95.6
12% (3 lots)	56	64.8	112.9
24% (1 lot)	18	62.9	103.2
Grouped by			
No Rice Products (4 lots).....	60	37.9	94.6
All lots not getting Brewers' Rice.....	306	45.5	100.5
18, 22 and 24% (5 lots).....	46	44.5	88.7
27.5 and 30% (2 lots).....	18	35.1	88.1
40 and 55% (3 lots).....	34	34.5	97.6
Grouped			
No Rice Products (4 lots).....	60	37.9	94.6
All lots not getting Rice Polish.....	259	44.9	101.4
6, 8, 10 and 10.4% (7 lots).....	55	40.0	88.8
11.6 and 12% (5 lots).....	77	54.1	107.4
20% (1 lot)	13	28.5	101.6

* Per cent hatched of fertile eggs.

TABLE 9

BY AMOUNT AND KIND OF RICE BY-PRODUCTS CONTAINED

RECORD		HATCHING RECORD			Average Egg Weight (grams)	Average Body Weight (grams)	Per Cent of Birds with Records	Per Cent with Records in Lot at end of Exptl. Period				
Days in Production	Per Cent Production for Exptl. Period	No. Eggs Set per Hen	Average Per Cent Fertility	Average Per Cent Hatch*								
PART I												
Per Cent Total Rice Products in Ration												
214.0	44.2	23.9	72.8	58.9	53.3	1478	80.9	71.7				
210.0	44.7	23.8	77.5	65.1	52.8	1480	65.1	80.8				
232.7	44.1	11.2	91.2	55.5	52.8	1586	76.2	87.5				
223.9	46.9	33.6	82.5	74.1	53.4	1436	56.8	69.6				
227.3	43.5	9.3	80.1	54.4	54.2	1548	72.6	82.5				
230.5	42.3	9.3	72.8	71.4	53.3	1533	72.1	82.2				
223.1	41.1	24.3	89.3	60.3	53.0	1426	65.8	80.4				
270.5	40.3	11.8	93.3	76.5	52.4	1629	50.0	100.0				
224.9	43.8	21.7	80.6	63.0	53.4	1502	66.5	84.2				
PART II												
Per Cent Untreated Rice Bran in Ration												
214.0	44.2	23.9	72.8	58.9	53.3	1478	80.9	71.7				
229.4	43.6	19.3	81.2	59.8	53.8	1509	69.5	80.6				
213.8	40.8	11.2	91.7	63.2	52.3	1553	71.2	88.9				
226.6	45.1	26.4	71.1	65.9	53.2	1469	60.3	73.2				
216.8	47.8	33.1	81.8	72.1	53.0	1420	60.6	63.8				
PART III												
Per Cent Treated Rice Bran in Ration												
214.0	44.2	23.9	72.8	58.9	53.3	1478	80.9	71.7				
220.4	43.4	23.8	81.4	63.3	53.0	1486	68.3	78.8				
251.3	44.9	8.2	75.7	72.8	54.5	1562	74.1	80.3				
225.1	45.9	9.9	77.3	32.8	55.1	1598	72.0	83.3				
PART IV												
Per Cent Brewers' Rice in Ration												
214.0	44.2	23.9	72.8	58.9	53.3	1478	80.9	71.7				
225.5	44.6	23.1	79.4	62.9	53.5	1495	70.9	76.8				
216.3	41.0	9.8	73.5	61.1	54.7	1541	67.4	87.0				
228.1	38.6	11.0	95.6	69.3	51.1	1474	62.5	88.9				
228.7	42.7	20.3	89.6	63.2	52.9	1520	61.3	85.3				
PART V												
Per Cent Rice Polish in Ration												
214.0	44.2	23.9	72.8	58.9	53.3	1478	80.9	71.7				
231.1	43.9	25.6	83.8	65.1	53.3	1548	73.4	79.5				
208.9	42.5	24.3	79.2	70.5	53.1	1516	61.7	85.5				
247.5	43.4	9.4	83.4	62.4	53.8	1555	73.3	83.1				
211.8	48.0	31.2	96.9	75.0	53.9	1398	52.0	84.6				

Total Rice Products in the Laying Ration

In part I of Table 9 the lots are arranged into eight groups with the rice by-products in the various groups ranging from none for the lowest group to 74.4% rice by-products in the highest group.

There was no tendency for winter egg production or per cent production for the experimental year to increase or to decrease as the rice products content of the ration varied. The simple correlation coefficient of total rice products in ration and per cent production for the experimental period (the lot used as a unit) was $-.175$. This indicates no sensible association since a coefficient of $.349$ is necessary to indicate significance.

The per cent fertility was apparently independent of the rice content of the ration. The hatchability of fertile eggs tended to increase as the rice products content of the ration increased, but that the association is not significant is shown by the coefficient of $-.202$ (with $.349$ required to indicate significance).

Neither egg weight nor body weight varied consistently with variation in "total rice products" in the ration.

Viability of the hens (considering jointly per cent of birds with records and birds in the pen at the end of the experimental period) was practically the same for all groups.

In general, the percentage of total rice products in the ration did not affect egg production, hatchability, egg weight, body weight, viability nor efficiency of the feed (simple $r = -.153$ with $.349$ required for significance.)

Rice Bran in the Laying Ration (Untreated and Treated)

It is a well known fact that rice bran becomes rancid upon being held in storage. Browne (loc. cit.) suggested long ago that heat treating rice bran might stop enzymatic action and prevent rancidity. A number of rice millers have bran driers which are used, however, with the primary object of reducing the moisture content and thus preventing shrinkage of rice bran.

In the fall of 1931 the State Feedstuffs and Fertilizer Testing Laboratory made tests as indicated in the following quotation (Kerr, 1933):

"Rice bran was run through a sugar dryer at a temperature ranging from 115 to 130 degrees Fahrenheit, remaining in the dryer from five to ten minutes. This material was then stored in a room with very little sunlight. In fact, the room contained no windows, but the top was not sealed; therefore, a little sun light could enter from this source, but no direct sun rays could reach the bran.

"When stored the moisture content of the dried bran was from two and one-half to three and one-half per cent, varying with the different sacks. The moisture content of the undried was from nine to twelve per cent, varying also with the different sacks.

"In April 1932, (circa 7 months after storage) this material was analyzed for moisture and the free fatty acid content of the oil. The moisture of the dried and the undried was practically the same, ranging around 9 to 10 per cent.

"There was no caked bran in either the dried or undried. The free fatty acid content of the oil was practically the same in the dried and undried, around 70 per cent, varying a little with the different sacks.

"The feed analyses of these two materials show little difference, which could be expected in any feeds.

"At this date (circa 10 months after storage), the undried material has a slight rancid odor, and is a little off color. The dried sample contains no odor of rancidity, and is all right in color."

The heat treated rice bran and untreated bran from the same lot were subsequently fed to lots in this experiment during 1931-32. See Tables 5 and 9.

In October, 1932, further drying tests were made by the author. Twenty-eight lots (200 lbs. per lot) of rice bran were heat-treated in a room type (Ramie) drier. The bran was spread out on galvanized iron trays in layers about 3 inches deep. The drier was heated by steam coils (steam pressure 50-52 lbs.) and was equipped with a motor driven 8-inch centrifugal fan connected by an 8-inch intake pipe and 6 inch exhaust pipe to the drying chamber. The air was thus recirculated continuously during the heating process. The rice bran was heated for one hour and the average temperature upon removal from the heated chamber was circa 140° F. (60° C.) The temperature of the bran 15 minutes after being placed in the chamber was about 46° C. and the temperature in the middle of a sack (sacked immediately as removed) had decreased 3° C. one-half hour after removed from the heated chamber. In other words the bran was thoroughly heated to 160° F.

The Feedstuffs Laboratory made fatty acid content tests (of oil) of treated and untreated bran (from same lot) on November 4 (about 1 month after date of treating). No difference was found in fatty acid content; 34.0% for untreated and 34.1% for treated. About 8 months later fatty acid determinations were again made. Again little difference was found in the treated and untreated samples. (For undried bran 83.77 and 82.18. For bran dried at 53° C. = 81.85 and for bran dried at 64° C. = 79.86). It was not possible to feed the treated vs. untreated rice bran in 1932-33, due to discontinuance of the project, but the treated bran was used in another experiment with good results.

It should be noted that in no case was the rice bran heated as high as 200° F., the temperature recommended by Browne (loc. cit.).

Part II, Table 9, gives the results with untreated rice bran and Part III results with treated rice bran. These two sections of the table are considered together.

Winter egg production and per cent production for the experimental year were as high, or higher in groups containing larger percentages of rice bran (treated and untreated) than for groups containing less rice bran or no rice bran at all. Winter egg production was higher for the treated rice bran groups than for the untreated bran groups, but this is probably due to the fact that all of the treated bran lots were given all-night lights whereas only 1 lot (of a total of 15) of "untreated bran" birds were given all-night lights. The per cent production for the experimental year did not differ essentially for the treated vs. untreated groups.

Hatchability tended to be higher in the untreated bran groups as the percentage of bran in the ration increased. The 12% treated bran group yielded good hatchability but the 24% treated bran group (only 1 lot) gave decidedly inferior hatching results.

No appreciable differences occurred in egg weight or in body weight, with either the treated or untreated groups.

The viability of the birds (i. e. % with records and in lot at end of experiment) in the two groups with higher content of untreated rice bran was appreciably lower than for any other groups.

Rice bran treated or untreated adequately replaced the other grain by-products used in laying rations.

Brewer's Rice in the Laying Ration

The groups fed brewer's rice as 27.5% to 55% of the total ration produced fewer winter eggs than other lots and tended to produce somewhat less for the year, although the decrease for the year is slight.

Eggs from hens fed brewer's rice hatched as well or better than those from hens on other rations.

Egg weight, body weight, and viability were apparently as good for the brewer's rice groups as for other groups.

Rice Polish in the Laying Ration

One lot of birds (13 individuals) which received 20% rice polish in the ration (Part V, table 9) produced fewer winter eggs, were smaller in body size and had lower viability than did the other groups to which they were compared. The small size of this group may account for the differences noted. With the above noted exceptions groups receiving rations containing rice polish were equal to or superior to groups not fed rice polish.

To summarize the results given in Table 9, it may be stated that untreated or treated rice bran, brewer's rice, rice polish or combinations of these products as used in the rations in these experiments, produced satisfactory egg production, hatchability, egg size, body weight and viability.

TABLE 10
STORAGE OF EGGS—SPRING OF 1929

	LOTS									Total
	1	2	3	4	5	6	7	8	9	
No. placed in Storage.....	37	42	46	39	32	30	39	39	25	329
Per cent Grade 2* after 132 days Storage	78.4	81.0	84.8	66.7	78.1	80.0	82.1	84.6	76.0	79.3
Per cent Grade 3 after 132 days Storage	21.6	19.0	15.2	33.3	21.9	20.0	17.9	15.4	24.0	20.7
Per cent Grade 3 after 206 days Storage	83.8	83.3	82.6	74.4	84.4	83.3	87.2	89.7	76.0	83.0
Per cent Grade 4 after 206 days Storage	13.5	16.7	17.4	25.6	12.5	16.7	12.8	10.3	24.0	16.4
Per cent inedible eggs after 206 days Storage	2.7	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.6
Rice Products in Ration.....	None	8.6†	11.6‡	6.9†	7.8†	24§	40§	7.8†	10.4‡	....
	....	....	....	10.4‡	11.6‡	....	....	27.5§	30.0§	....
	....	....	....	....	55.0§	....	....	....	....	....

* Grades are based on U. S. Standards of Quality for Individual Eggs—U. S. Department Agr., Bur. Agr. Econ.
Grade 2 = U. S. Extras, 3 = U. S. Standards, and 4 = U. S. Trades.

† Bran. ‡ Polish. § Brewers' Rice.

KEEPING QUALITY OF EGGS FROM HENS FED RICE BY-PRODUCTS

Tables 10 and 11 contain data concerning the keeping quality of eggs produced by hens fed various "rice-products" rations.

Table 10 presents the results of storing eggs from nine lots during the 1929 season. Relatively few eggs (about 3 dozen) were stored from each lot in this test, but the results were uniform enough and good enough to indicate that eggs from all of the rations used kept very well in storage. Lots 4 and 9 had larger percentages of grade 4 eggs than did the other lots but even in these lots the quality of the eggs was entirely satisfactory. The percentage of "loss" eggs was negligible.

Table 11 gives the storage results with three cases of "rice-products" eggs as compared to the average results of 47 cases of eggs from hens receiving no rice products in the ration. These figures are taken from work reported in Louisiana Station Bulletin 229—Upp (1932).

It may be noted that the "rice-products" eggs compared favorably with the other eggs in average grade into storage, average grade out of storage, percentage of "loss" eggs and in "loss" eggs with broken eggs omitted (i. e. inedible eggs).

It is apparent that eggs produced on rice products diets are entirely satisfactory for storage purposes.

TABLE 11
STORAGE OF EGGS FROM HENS IN RICE EXPERIMENTS*

Case	Year	Average Grade into Storage	Average Grade out of Storage	Average Loss in Grade	No. Days in Storage	% of Eggs Graded as "Loss" at end of Season	% of "Loss" Eggs with broken eggs omitted
9	1929	1.86	3.16	1.30	206	.83	.56
4	1930	2.27	3.78	1.51	207	.83	0.00
4	1931	2.34	3.46	1.12	202	1.67	.27
Average of the three "rice" cases		2.16	3.47	1.31	205	1.11	.28
Average of 47 other cases stored		2.37	3.65	1.28	(C'rcu) (220)	2.68	1.50

* Approximately the same number of eggs was stored from all pens in the rice experiments during the three years indicated. No exact record was made of the eggs from each pen except during the 1929 season. (See Table 10.)

TABLE 12
GROWTH OF CHICKS FROM HENS FED VARIOUS RICE RATIONS*
Season of 1929

Lot No.	% Rice in Ration of Dams	Day Old	Age in Weeks						
			1	2	3	4	5	6	12†
1	None	32	48	84	138	205	294	395	641
2	8.6 Bran	34	46	69	105	154	223	259	661
3	11.6 Polish	35	51	85	125	192	272	326	661
4	6.9 Bran {	35	49	76	119	175	236	291	592
	10.4 Polish }								
5	7.8 Bran {								
	11.6 Polish }	34	47	75	114	161	234	275	606
	55.0 Brewers' Rice }								
6	24.0 Brewers' Rice	35	48	74	116	165	222	321	†
7	40.0 Brewers' Rice	34	48	79	122	166	251	301	630
8	7.8 Bran {	34	47	78	117	157	222	307	685
	27.5 Brewers' Rice }								
9	10.4 Polish {	35	51	81	116	165	233	293	665
	30.0 Brewers' Rice }								

* The chicks all received the same ration and were brooded under similar conditions.

† Only pullets were weighed at 12 weeks of age.

‡ Too few individuals in lot—Mortality exceptionally high in this lot. (No appreciable difference in mortality in other lots.)

Growth of Chicks from Hens Fed Various "Rice Rations"

During the spring of 1929 a representative group of chicks was hatched from each of the nine lots on test. The chicks from all lots received the same ration and were brooded under similar conditions.

The average weights of all lots are given in Table 12 for day old and 1, 2, 3, 4, 5 and 6 weeks old chicks. The weights of pullets at 12 weeks of age are also given.

The rate of growth was greatest for the check lot for the first six weeks but the average 12 week weight of the pullets in this lot was no greater than that for the other lots. All of the lots, except as noted above, were essentially uniform in rate of growth.

SUMMARY

1. The rations containing rice by-products compared favorably, in general, with the check rations in the production of winter eggs.
2. The birds on diets in which rice products were included produced as well for the year, on the average, as those receiving the check rations.
3. No rice product or combination of products as used during these experiments was distinctly detrimental to egg production.
4. Rations in which rice products were included were fully equal to the basal ration as gauged by the average length of the productive period for the various lots. No one product was outstandingly superior or inferior in this respect.
5. For the series of experiments as a whole, no consistent, significant differences in hatchability were associated with any rice product or combination of products. The rations containing rice products compared favorably in hatching results with the check rations.
6. No definite association was found between the various rations used and egg weight.
7. Average body size for the year was apparently independent of the ration used. There was no evidence that any of the rations used had any particular seasonal influence upon body weight. The birds in all lots tended to lose somewhat in body weight between February 1 and August 1 of their first laying year.
8. In a short test rough rice appeared to be a nutritious, palatable grain feed for chickens. Subsequent experience has borne out this conclusion. Rough rice (ground) was also used with satisfaction as 40% of an all-mash laying ration.
9. A comparison of the records of birds that died during the year with those that lived, revealed that the survivors were superior in every way tested to those that died.
10. Considering the entire series of experiments, the rations containing rice by-products gave satisfactory efficiency (based upon lbs. of feed per dozen eggs) as compared to the check rations.

11. The percentage of the total ration composed of rice by-products (ranging in content from 0 to 74.4%) did not affect consistently the winter egg record, egg production for the year, hatching record, egg size, average yearly body weight, viability of the hens nor efficiency of the ration in these experiments.

12. Rice bran (untreated and heat treated) yielded entirely satisfactory results when used to replace wheat bran or pulverized whole oats or wheat bran and wheat shorts, or part of the yellow corn meal in laying rations.

13. Brewer's rice was used successfully at 18% to 55% levels in laying rations, to replace oats, wheat or corn in the "scratch" grain or part of the yellow corn meal in all-mash rations.

14. Rice polish proved to be an entirely adequate replacement for ground oats, wheat shorts, wheat bran, or both bran and shorts in laying rations.

15. Rice bran, rice polish and brewer's rice were used in various combinations and for several different substitutions with good results.

16. Eggs from "rice-fed" hens were of good quality and kept well in storage. They compared favorably in quality to eggs produced under similar conditions but by hens on "non-rice" rations.

17. Heating rice bran to 140° F. did not lessen the percentage of free-fatty acids present after several months storage.

18. Pullets from "rice-fed" dams were as large at twelve weeks of age as were pullets from dams fed a check ration when all lots of chicks were fed and cared for in like manner.

CONCLUSIONS

Rice by-products can be used with entire satisfaction in rations for laying hens.

Rice by-products might well be used more extensively in laying rations in Louisiana to replace other grain by-products now imported from other regions.

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APPENDIX

Suggested Rations Utilizing Rice Products

Laying Mashers (Grain mixture to be fed with these mashers)

No. 1 (Simple)		No. 2 (Simple)	
	lbs.		lbs.
Ground yellow corn (corn meal)	200	Ground yellow corn (corn meal)	200
Rice bran (good quality)	100	Ground rough rice	200
Rice polish	100	Meat scrap (or shrimp meal)	100
Meat scrap (or shrimp meal*)	100		
	<hr/> 500		<hr/> 500

The above rations are improved considerably by the addition of 25 lbs. of alfalfa leaf meal and 25 lbs. of mineral mixture.

No. 3		No. 4	
Ground yellow corn	36	Ground yellow corn	30
Rice bran	16	Rice bran	16
Rice polish	16	Brewer's rice (ground)	22
Meat scrap	16	Meat scrap	16
Dried buttermilk	5	Dried buttermilk	5
Alfalfa leaf meal	5	Alfalfa leaf meal	5
Mineral mixture	6	Mineral mixture	6
	<hr/> 100		<hr/> 100

Mineral Mixture for all Laying Mashers

6 parts pulverized oyster shell
 3 parts bone meal.
 1 part salt.

*Shrimp meal may be used in any laying mash in place of meat scrap, however it is advisable to omit the mineral mixture when shrimp meal is used.

Grain Mixtures—(To be fed with any of the above mashes.)

No. 1		No. 2	
Yellow corn (cracked or whole "Creole" or dent corn)	100	Yellow corn	100
Rough rice	100	Wheat	100
		Brewer's rice*	100
No. 3		No. 4	
Yellow corn	100	Brewer's rice	100
Heavy oats	100	Yellow corn (or wheat)	100
Brewer's rice	100		

* Trough or hopper feeding grain is advised when brewer's rice is used, because of small size of particles. Many poultrymen prefer trough feeding instead of "litter" feeding, for all grains.

All-Mash Rations (No grain to be fed in addition)

No. 1		No. 2	
Whole ground yellow corn	50	Whole ground yellow corn	50
Rice bran	16	Ground rough rice	22
Rice polish (or ground brewer's rice)	16	Rice polish	10
Meat scrap**	8	Meat scrap**	8
Dried buttermilk	4	Dried buttermilk	4
Alfalfa leaf meal	3	Alfalfa leaf meal	3
Mineral mixture	3	Mineral mixture	3

** If shrimp meal is used instead of meat scrap, use 11 lbs. and omit the mineral mixture.